

Evaluation of Innovation Management in Developing Countries: A Comparative Study

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ABSTRACT

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KEYWORDS

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The objective of this paper is to evaluate the management of technological innovation in one of the largest petrochemical companies in Saudi Arabia and to illustrate how to benchmark the results with the innovation management of other organizations. The evaluation consisted of five dimensions: strategy, processes, innovative organization, linkages and learning. The results showed that the Saudi Company has top management commitment and support for innovation, the learning dimension is very well managed, the company is committed to the development of its employees worldwide and the innovation system is flexible. The results also showed that the linkages and process dimensions ranked in the middle and the innovative organization and strategy dimensions have lower ranks. The results were compared with two Brazilian companies: "Arinos" and "Poly Easy"; and two Chinese companies: "Guizhou YiBai Pharmaceutical" and "Huagong Tools". These companies are not similar to the Saudi Company in so many aspects; however, the comparisons were made for illustration reasons only in order to illustrate how it could be implemented and how to use the results to benchmark innovation management in organizations. The comparisons results revealed that the Saudi Company was doing better in several dimensions. It was 6.7% better than Guizhou YiBai Pharmaceutical Company in the process dimension and better than Arinos in the linkages and learning dimensions by 10% and 0.57% respectively. Some of the gaps between the Saudi Company and the average of the two Chinese companies and the average of the two Brazilian companies were small and could easily be closed.

تقييم إدارة الابتكار التقني في الدول النامية: دراسة مقارنة

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المُستخلص

هدف هذا البحث هو تقييم إدارة الابتكار التقني في احد أكبر شركات البتر وكيمويات في المملكة العربية السعودية و توضيح كيفية مقارنة نتائج التقييم مع المؤسسات الأخرى. عملية التقييم تكونت من خمسة محاور: الإستراتيجية، العمليات، الهيكلية الإبتكارية، الترابط والتعليم. أظهرت نتائج البحث أن الشركة السعودية تتمتع بالالتزام والتأييد للإبتكار من الإدارة العليا، وكذلك فإن محور "التعليم" يدار بإدارة عالية الفعالية، وإن الشركة ملتزمة بتطوير موظفيها والعاملين بها على المستوى العالمي، وكذلك تمتاز الشركة بمرونة نظام الابتكار. كما أظهرت النتائج أن محاور الترابط والعمليات كان ترتيبهم في الوسط من حيث الترتيب، وإن الهيكلية الإبتكارية والإستراتيجية جاءت بعد من ذلك في الترتيب. تم مقارنة هذه النتائج بنتائج شركتين من البرازيل: "أرينوس" و"بولي ايزي" وكذلك شركتين من الصين: "جيزهو ويباي" و"هيوحنج". هذه الشركات غير متماثلة مع الشركة السعودية في نواحي عديدة و تم عمل المقارنات فقط لشرح كيفية تطبيق المقارنات و كيفية استخدام النتائج لمقارنة إدارة الابتكار للمؤسسات. نتائج المقارنات أظهرت أن الشركة السعودية أفضل من شركة "جيزهو ويباي" الصينية في محور العمليات وأفضل من شركة "أرينوس" البرازيلية في محاور الارتباط والتعليم وذلك بالنسب المئوية التالية على الترتيب: 6.7% و 10% و 0.57%. بينت النتائج أيضا أن بعض الفجوات بين الشركة السعودية وهذه الشركات فجوات صغيرة وممكن تعويضها بسهولة.

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الكلمات الدالة

*المقارنة المعيارية، الابتكار التقني،
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Introduction

The perceptions of technology and innovation have changed over time. Economists were interested in technological progress and its impact on employment. Smith, Ricardo, Marx, Roberts, von Hayek and Schumpeter had different theories about technology and its impact on economics. Schumpeter was one of the first economists to define innovation in 1939, he stated that innovation is “the launching of a new product or of new form of organization, the accomplishment of a merger or the opening of new markets” (Flichy, 2007). A modern and widely used definition of innovation is given in the Oslo Manual (OECD and Eurostat, 2005) as “the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations”. In our modern dynamic world, many authors argue that although the management of innovation is risky, technological innovation is an essential driver of competitiveness (Tidd & Bessant, 2009; Betz, 2011; Stamm & Trifilova, 2009). Hidalgo and Albers (2008) added that creating a culture of innovation is the best assurance for organizations to have long life within vibrant markets. This recognition of the importance of innovation has caused the body of innovation management literature to increase over the last 4 decades (Eveleens, 2010) that the number of papers and books searched in Science Direct about innovation management was almost equal to one from 1975 until 1979 and reached around 800 from 2005 until 2009.

A World Bank Institute report describe the innovation climates in developing countries as problematic, characterized by poor business and governance conditions, low educational levels, bureaucratic climate and mediocre infrastructure (Aubert, 2004). The World Bank (2010) recommended that governments need to pay attention to innovation, particularly in the developing world, because innovation is the key driver of economic development and it is the main tool to cope with major global challenges. A report

made by UNESCO (2010) stated that even oil-rich-Arab states need innovation. Despite the need for innovation, the literature shows that the Arab countries lag far behind developed countries in terms of science and technology and there are very few published works that evaluate technological innovation in organizations in the Arab world (Alsanad, and Abdel-Razek, 2013). Hence, there is a need for research in the areas of innovation and its management in this region. The objective of this paper is to evaluate the management of technological innovation in one of the largest Saudi petrochemical companies and illustrate how this evaluation could be compared with other companies in developing countries in order to analyze and evaluate how well the company manages innovation.

Evaluation of Innovation Management

Innovation audit is defined as “*a tool that can be used to reflect on how the innovation is managed in a firm*” (Lima, 2011). Innovation audit is a significant breakthrough in the area of technological innovation management (Liao et al. 2011). There are several tools and frameworks to audit innovation management. One framework was suggested to audit innovation against a core process model which consisted of concept generation, product development, process innovation and technology acquisition (Chiesa et al., 1996). Another framework, “inventory for organization innovativeness”, was proposed by Tang (1999) and intended to measure organizational effectiveness in innovation. Mentz (1999) developed what he called a “competence audit for technological innovation”, the aim was to check the organization’s abilities relative to best practices in innovation. Radnor and Noke (2002) presented a self-diagnostic tool referred to as the “innovation compass” to pinpoint gaps between current and desired performance of organizations regarding innovation. Another innovation audit framework was suggested by Goffin and Mitchell (2010) for identifying strengths and weaknesses using the “Pentathlon Framework”. A recent audit tool was presented by Tidd and Bessant (2009) who have identified the factors that influence the success and failure

of innovation and used these factors to develop an audit tool for assessing innovation management in organizations. It focuses attention on five key areas of innovation management: strategy, process, organization, linkages and learning. Abdel-Razek and Alsanad (2013) explained a methodology to evaluate innovation by simultaneous mapping and auditing. They followed that by comparing innovation management in organizations Abdel-Razek and Alsanad (2014).

The Comparative Study

1. The Petrochemical Industry in Saudi Arabia and the Case Company

Petrochemicals are making their impact worldwide as they are an essential part of our everyday lives. There is a wide range of petrochemical products, such as cables, book covers, rubber, plastic and a multitude of everyday items. As petrochemicals play a vital role in economics and also in our everyday lives, the demand on it grows day after day making it one of the most competitive and innovative industries. Two decades ago, Saudi Arabia appeared an unlikely location for a major industrialization drive (Ramady, 2010). Today the Saudi economy is controlled by two key sectors, oil and petrochemical. The petrochemical industry accounts for 5% of Saudi GDP and 34% of the value of its stock market (AlRajhi Capital, 2010). A report published by the Oxford Business Group (2007) stated that Saudi Arabia is one of the largest petrochemical-producing countries in the world, and that in recent years it has managed an output almost equal to China's. Another report stated that Saudi Arabia is supplying over one hundred countries and accounting for about seven percent of the worldwide supply of basic petrochemical products (Oxford Business Group, 2009).

This study is implemented in one of the largest petrochemical companies in Saudi Arabia. It operates in more than forty countries with more than thirty three thousand employees across the world and has seven technology centers distributed around the globe. The company is composed of six business units: chemicals, polymers, performance chemicals, fertilizers, metals and innovative

plastics. For reasons of data confidentiality, the company will be called in this paper "the Saudi Company".

2. Research Tool and Participants

The selected tool to audit innovation was developed by Tidd and Bessant (2009). The questionnaire composed of five audit dimensions: strategy, learning, linkages, processes and innovative organization. It consists of forty statements which describe "the way we do things around here". For each statement, a score between 1 to 7 is determined. The scores determine the respondents' degree of agreement or disagreement that the statements are true. Strongly agree has a value of 7, agree 6, somewhat agree 5, undecided 4, somewhat disagree 3, disagree 2 and strongly disagree 1.

One of the company's technology centers that considered of being the closest to innovation activities is the Technical Services Lab. The questionnaires were distributed and answered by all the 50 employees working in the Technical Services Lab (Alsanad, 2013). The surveyed employees were categorized according to their job title as shown in table 1. This table shows that the highest percentages of participants are engineers (36%), followed by scientists (20%), and followed by both administrators and technicians with (22%) each. Employees were also categorized into four levels according to their educational qualifications. Table 2 shows that 8% of the respondents are PhD holders, 16% are Master degrees holders, 22% are Post Graduates Diploma holders and 54% are Bachelor holders.

Table 1: Participants' Job Titles

Job Role	Employees	Participants	Percentage	Rate
Scientists	10	10	20%	100%
Engineers	18	18	36%	100%
Administrators	11	11	22%	100%
Technicians	11	11	22%	100%
Total	50	50	100%	100%

Table 2: Respondents' Qualifications

Degree	Respondents	Percentage
PhD	4	8%
Master's	8	16%
Bachelor	27	54%
Diploma	11	22%
Total	50	100%

Evaluation of the Company's Innovation Management

1. Overall Evaluation of Innovation Management

The collected data were analyzed and the average scores given by the respondents to each of the auditing statement of the five audit dimensions are summarized in table 3. The results showed that the average score of the learning dimension is the highest, 5.04, which indicates that the employees are satisfied and agree that the company is managing the learning aspect very well. The linkages and process dimensions ranked in the middle while the innovative organization and strategy aspects received lower scores as shown in table 3 and illustrated in figure 1.

Table 3: Evaluation Results

Strategy		Process		Innovative Organization		Linkages		Learning	
S	M	S	M	S	M	S	M	S	M
1	4.46	2	4.54	3	4.58	4	5.68	5	4.84
6	4.30	7	4.30	8	4.64	9	4.82	10	5.38
11	4.42	12	4.58	13	4.48	14	3.86	15	5.86
16	4.48	17	4.36	18	3.98	19	4.78	20	5.22
21	4.34	22	4.94	23	4.38	24	4.22	25	4.92
26	5.10	27	4.32	28	4.96	29	4.84	30	4.62
31	4.22	32	4.40	33	4.16	34	4.46	35	4.82
36	4.82	37	5.12	38	5.04	39	5.04	40	4.62
Total	36.14		36.56		36.22		37.70		40.28
Score	4.52		4.57		4.53		4.71		5.04
Rank	5		3		4		2		1

(S: Statement No/ M: Means)

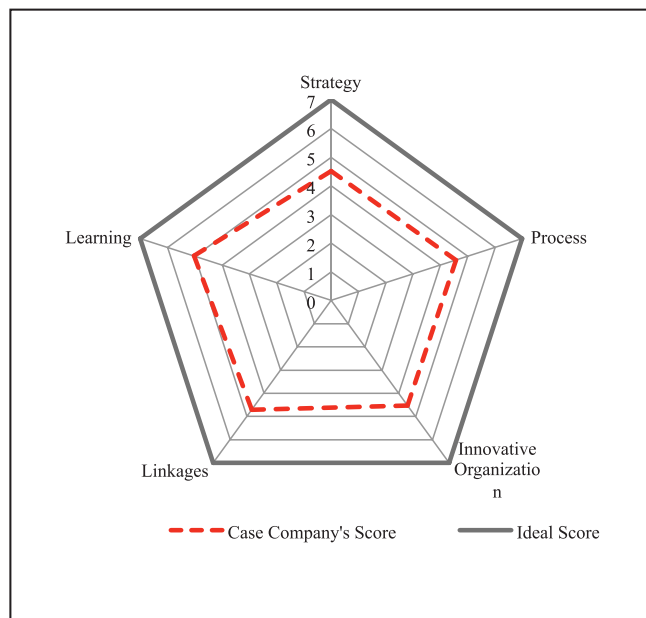


Figure 1: Overall Innovation Management Results

1.1. Learning Dimension

The learning dimension stands out as the highest ranking among the five dimensions of the audit as shown in table 3. The results showed that the company has established itself as a learning organization. An in-house teaching structure has been established which focuses on learning the real, day-to-day challenges that managers and teams face in order to develop new skills which allow them to reach their full potentials. The average score of 5.04 out of 7 signifies that the employees agree that the company is managing the learning aspects well. Among all of the 40 audit statements, statement number 15: "We learn from our mistakes" received the highest score. The results also showed that the company works closely with its customers and end-user. Statement number 10: "We are good at understanding the needs of our customers/end-users" received a relatively high score of 5.38.

1.2. Strategy Dimension

Strategy received the lowest average score of 4.52 among the five dimensions of innovation audit and was ranked the fifth and last. This indicated that strategy could be considered one of the company's weaknesses from an innovation audit view. Statement 31 of the strategy dimension: "We have processes in place to review new

technological or market developments and what they mean for our firm's strategy", received the lowest score of 4.22 among all the eight strategy statements. This showed that employees think that there is a lack of processes to analyze new technological or market developments which affects the firm's strategy negatively. However, the results also showed that the participants mostly agree that there is top management commitment and support for innovation, as statement number 26: "There is top management commitment and support for innovation" received the highest score of 5.1 among the eight strategy statement.

1.3. Process Dimension

The process dimension ranked third out of the five dimensions with an average score of 4.57. Statement 37 of the survey: "There is sufficient flexibility in our system for product development to allow small 'fast-track' projects to happen", received the highest score of 5.12 among the eight statements that are concerned with the process dimension. Therefore, the positive element in this aspect is that the company has flexibility in their innovation system. However, statement number 7: "Our innovation projects are usually completed on time and within budget", received the lowest score of 4.3 which implies that there are some flaws in the process.

1.4. Innovative Organization Dimension

The innovative organization dimension ranked fourth out of the five innovation audit dimensions, with a 4.53 score. Table 3 shows that the highest score in the eight statements of the organization dimension was 5.04 and was given to statement number 38: "We work well in teams" (5.04). The lowest score was 3.98 and was given to the statements number 18: "Our structure helps us to take decisions rapidly". This lowest score statement is linked to deficiency and problems in the innovation organizational structure which doesn't allow, among other things, taking decision rapidly. The second lowest score was 4.16 and was given to statement number 33: "We have a supportive climate for new ideas – people don't have to leave the organization to make them

happen". This low score is linked with deficiencies in the organization's innovative climate.

1.5. Linkages Dimension

This dimension ranked second among the five audit dimensions. It implies that this dimension is managed relatively well. The highest score in this dimension was 4.7 and was given to statement number 4: "There is a strong commitment to training and development of people". This score and other statements scores showed that the company is committed to training its employees. The organization invests in its employees worldwide in terms of training and education, both in-house and in partnership with academic institutions in order to achieve its vision. However, the lowest score was 3.86 and was given to statement number 14: "We work well with universities and other research centers to help us develop our knowledge". This problem is more emphasized by knowing that this statement was given the lowest score among all forty statements in the 5 dimensions. This is most probably due to the fear of leaking their projects to others.

2. Evaluation of Innovation Management by Each Job Title

The Technical Services Lab (TSL) employees were classified according to their job titles: scientists, engineers, administrators and technicians. The audit results for each job are demonstrated in table 4 and figure 2.

Table 4: Results of Evaluating Innovation Management by Each Job Title

Job Role \ Dims.	Strategy	Process	Innovative Organization	Linkages	Learning
Scientists	5.03	4.93	4.65	4.50	5.48
Engineers	4.49	4.78	4.78	4.83	5.38
Technicians	3.91	4.30	3.87	4.56	4.07
Administrators	4.72	4.18	4.64	4.86	5.04

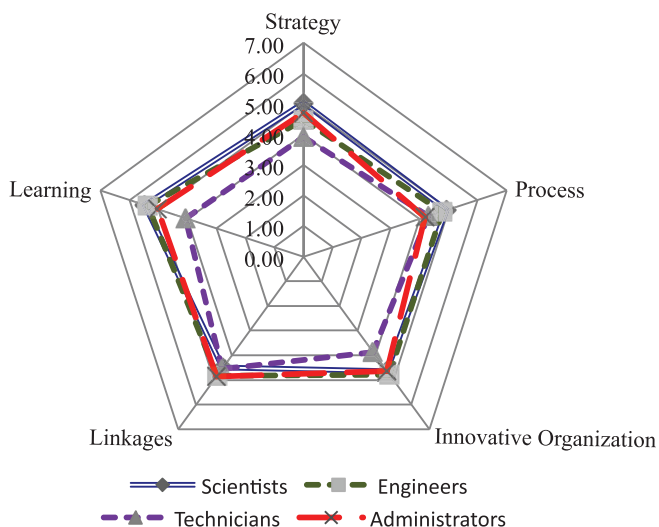


Figure 2: Evaluation of Innovation Management by Each Job Title

The results showed that scientists are the most satisfied group with how well the company manages innovation. They gave the highest scores in matters related to strategy, process and learning, with average scores of 5.03, 4.93 and 5.48 out of 7 respectively. Engineers are the second most pleased group about how well the company manages innovation. They gave the highest score to the innovative organization dimension among the four employee groups with a score of 4.78. Administrators gave the highest score of 4.86 for linkages dimension, their view to the strategy dimension is better than engineers and technicians. Technicians on the other hand, are the least satisfied group with the way the organization manages innovation. They gave the lowest score among the four groups in strategy, innovative organization and learning.

Comparative Analysis of Innovation Management

1. Comparing the Company’s Innovation Management with Chinese and Brazilian Companies

The same audit tool (Tidd and Bessant, 2009) was implemented in several organizations in different countries. Ye and Zhou (2009) and Pang and Qu (2010) applied the questionnaire in Chinese companies. Lima (2011) also used the questionnaire for auditing two Brazilian companies. The scores given by the case company were compared to those of the companies in China and in Brazil. The results were compared with the two Brazilian companies: “Arinos” and “Poly Easy”; and with the two Chinese companies: “Guizhou YiBai Pharmaceutical” and “Huagong Tools”. These companies are not similar to the Saudi Company in so many aspects; however, because no current results are published on petrochemical companies the comparisons were made with these companies for illustration reasons only in order to illustrate how it could be implemented and how it could be used to compare and benchmark innovation management in organizations. The comparisons results neither represent all Saudi, Chinese or Brazilian organizations; nor do they represent the petrochemical organizations in Saudi Arabia. However, the comparisons are useful in demonstrating how they could be done and illustrating the usefulness of auditing innovation when the relevant data are available. Table 5 shows the scores of the Saudi Company, two Chinese companies (Huagong Tools Co. and Guizhou YiBai Pharmaceutical Co. Ltd) and two Brazilian companies (Poly Easy and Arinos).

Table 5: Comparison between the Company’s Innovation Management and Four other Companies

Company	Strategy	Processes	Innovative Organization	Linkages	Learning
The Saudi Company scores	4.52	4.57	4.53	4.71	5.04
Score as a percentage (%)	64.57	65.29	64.71	67.29	72.00
Huagong Tools Company	4.75	6.38	5.50	5.18	5.32
Score as a percentage (%)	67.86	91.07	78.57	74.00	76.02

Company	Strategy	Processes	Innovative Organization	Linkages	Learning
Difference between The Saudi Company scores & Huagong Tools (%)	3.29	25.79	13.86	6.71	4.02
Guizhou YiBai Pharmaceutical Co. Ltd.	4.90	4.10	5.10	5.40	5.30
Score as a percentage (%)	70.00	58.57	72.86	77.14	75.71
Difference between The Saudi Company scores & Guizhou YiBai (%)	5.43	-6.71	8.14	9.86	3.71
Poly Easy	5.60	5.50	5.30	5.50	5.60
Score as a percentage (%)	80.00	78.57	75.71	78.57	80.00
Difference between The Saudi Company scores & Poly Easy (%)	15.43	13.29	11.00	11.29	8.00
Arinos	5.50	4.60	4.90	4.00	5.00
Score as a percentage (%)	78.57	65.71	70.00	57.14	71.43
Difference between The Saudi Company scores & Arinos (%)	14.00	0.43	5.29	-10.14	-0.57

2. Comparison between the Five Companies

The scores and the percentage differences between the Saudi Company and each of the four companies were analyzed for each of the five dimensions and are given in table 5. The results revealed that the Saudi Company was doing better than some of the other companies in various dimensions as indicated by the negative signs in table 5. The results showed that it was 6.7% better than Guizhou YiBai Pharmaceutical Company in the process dimension and better than Arinos in the linkages and learning dimensions by 10% and 0.57% respectively. The smallest difference of 0.43% was between the Brazilian company “Arinos” and the Saudi Company in the process dimension. The comparison also showed that, among the five companies, the Saudi Company ranked the lowest in the strategy and innovative organization dimensions. It ranked fourth in process, linkages and learning. The Brazilian company “Poly Easy” is doing best in strategy, linkages and learning dimensions, while the Chinese company “Huagong Tools” is leading in the process and innovative organization dimensions. The results are illustrated in figure 3.

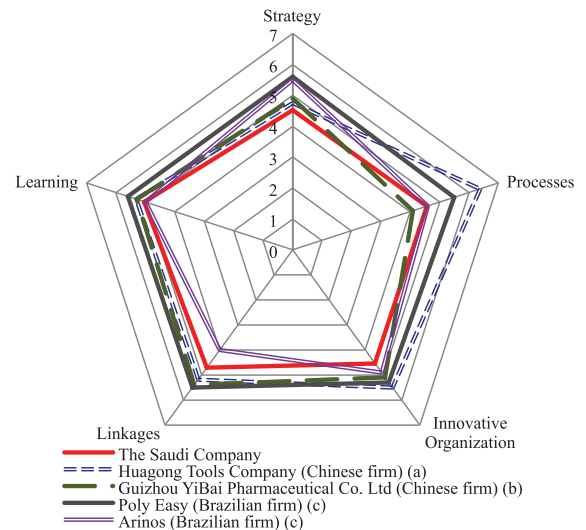


Figure 3: Comparison between the Innovation Management of the Five Companies

3. Comparison between the Saudi Company and the Average of the Chinese and Brazilian Companies

The comparisons between the Saudi Company and the average of the two Chinese companies and the average of the two Brazilian companies were also analyzed for each of the five dimensions and the results are given in table 6.

Table 6: Comparison between the Innovation Management in the Saudi Company and the Average of Chinese and Brazilian Companies

Company	Strategy	Processes	Innovative Organization	Linkages	Learning
The Saudi Company	4.52	4.57	4.53	4.71	5.04
Score as a percentage (%)	64.57%	65.29%	64.67%	67.29%	72.00%
Average of Chinese companies	4.83	5.24	5.30	5.29	5.31
Score as a percentage (%)	68.93%	74.82%	75.71%	75.57%	75.87%
Average of Brazilian companies	5.55	5.05	5.10	4.75	5.30
Score as a percentage (%)	79.29%	72.14%	72.86%	67.86%	75.71%
Average difference between the Saudi Company and the Chinese companies	4.36%	9.54%	11.04%	8.29%	3.87%
Average difference between the Saudi Company and the Brazilian Companies	14.71%	6.86%	8.19%	0.57%	3.71%

The results showed that the Chinese companies have the highest scores in processes, innovative organization, linkages and learning dimensions whereas the Brazilian companies received the highest score in the strategy dimension, this is illustrated in figure 4.

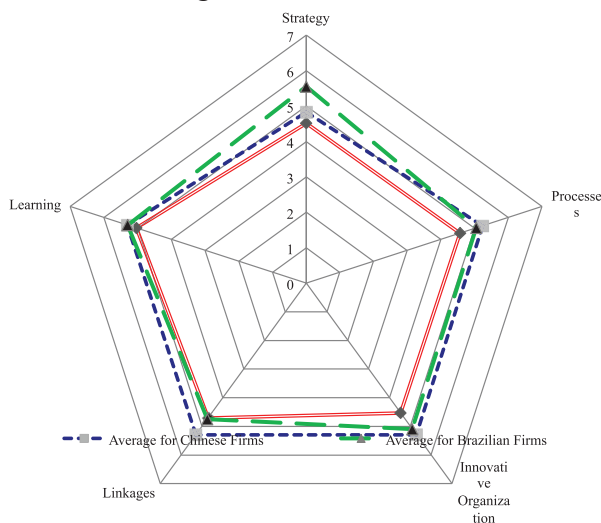


Figure 4: Analysis of the Innovation Management of the Saudi, Chinese and Brazilian Companies

The results also revealed that the Saudi Company has similar strengths and weaknesses as the average of the Chinese firms. They both showed strength in learning and weakness in strategy. While the Brazilian firms showed strength in the strategy and weakness in the linkages dimensions. The results also showed that the differences between the Saudi Company and the two groups are small and range between 0.57% and 14.71%.

The comparison between the Saudi Company and the Brazilian companies showed that the greatest gap of 14.71% was in the strategy dimension whereas the smallest gap of 0.57% occurred in the linkages dimension. The comparison with the Chinese companies showed that the greatest gap of 11.04% was in the strategy dimension whereas the smallest gap of 3.87% occurred in the linkages dimension. However, some of the gaps between the Saudi Company and the average of the two Chinese firms and the average of the two Brazilian firms could easily be closed. For example, the Saudi Company’s results are almost equal to the average of the two Brazilian firms regarding the linkages dimension with only 0.57% difference.

Conclusions

The technological innovation management of one of the largest petrochemical companies in Saudi Arabia was evaluated. The evaluation consisted of five dimensions: strategy, processes, innovative organization, linkages and learning. The results showed that the Saudi company has top management commitment and support for innovation. Learning is very well managed and stands out as the highest ranking among the five evaluated dimensions. The company is committed to the development of its employees worldwide and its innovation system is flexible enough to allow specified small innovation projects to be fast-tracked. The results also showed

that the linkages and process dimensions ranked in the middle and the innovative organization and strategy dimensions had lower ranks. The most satisfied employees with the company's innovation management are researchers, while technicians are the least content.

The results were compared with two Brazilian companies: "Arinos" and "Poly Easy"; and two Chinese companies: "Guizhou YiBai Pharmaceutical" and "Huagong Tools". These companies are not similar to the Saudi Company in so many aspects and the comparisons should be made with similar companies; however, studies from China and Brazil were selected because of the lack of published work in this area and because no current results are published on petrochemical companies. The comparisons were made for illustration reasons only in order to illustrate how it could be implemented and how to use the results to compare and benchmark innovation management in organizations.

The comparisons between the Saudi Company and each of the four companies revealed that the Saudi Company was doing better in several dimensions. It was 6.7% better than Guizhou YiBai Pharmaceutical Company in the process dimension and better than Arinos in the linkages and learning dimensions by 10% and 0.57% respectively. Some of the gaps between the Saudi Company and the average of the two Chinese companies and the average of the two Brazilian companies are small and could easily be closed. For example, the Saudi Company's results are almost equal to the average of the two Brazilian firms regarding the linkages dimension with only 0.57% difference. Among the five companies, the Brazilian company "Poly Easy" is doing best in the strategy and learning dimensions, while the Chinese company "Huagong Tools" is leading in the process and innovative organization dimensions. The Saudi Company has similar strengths and weaknesses as the average of the Chinese companies. They both showed strength in learning and weakness in strategy.

The comparisons results neither represent all Saudi, Chinese or Brazilian organizations; nor do they represent the petrochemical organizations in Saudi Arabia. However, the comparisons are useful

in demonstrating how they could be implemented and illustrating the usefulness of innovation auditing when the relevant data are available.

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